BP 22: Posters - Neurosciences

Time: Monday 17:30–19:30 Location: Poster C

BP 22.1 Mon 17:30 Poster C

Putative role of stochastic resonance in tinnitus — •Christian Schuetz[1,2], Patrick Krauss[1,2], Claus Metzner[2], and Holger Schulze[1] — [1]Experimental Otolaryngology, ENT-Hospital, University of Erlangen, Germany — [2]Department of Physics, Biophysics Group, University of Erlangen, Germany

Maladaptive processes within the auditory system following damages of the inner ear are discussed as the origin of the phantom perception of tinnitus. Models of tinnitus development postulate that acoustic trauma initially leads to reduced input into auditory nerve fibers. Remarkably, the neural activity within the central auditory pathway increases. This finding led to models of increased neuronal gain underlying the perception of tinnitus, but the source and control of this gain still remains elusive. We here investigate the role of stochastic resonance in neural sensory systems and its putative influence on the development of tinnitus. We construct a biologically plausible neural network of leaky integrate-and-fire neurons that models the auditory system and adjusts the appropriate level of noise via a feedback loop to maintain maximum information transmission in terms of mutual information. So far, we were able to show in our model that reduced input leads to increased network activity, which is perfectly consistent with experimental data. Furthermore, by adding plasticity to our model we demonstrate how long-term auditory phantom percepts, namely tinnitus, may emerge from short-term changes of processing dynamics.

BP 22.2 Mon 17:30 Poster C

How to estimate a threshold: theoretical limitations and practical implications — •Achim Schilling, Patrick Krauss, Konstantin Tziridis, and Holger Schulze — Experimental Otolaryngology, ENT-Hospital, University of Erlangen

We present a novel and robust method to universally estimate physiological and behavioral thresholds using the example of measurements of auditory brainstem responses (ABR) and pre-pulse inhibition (PPI) of acoustic startle responses (ASR). By definition the threshold defines the weakest stimulus strength that evokes a response significantly different from the non-stimulus condition. It is common practice that for threshold estimation measurements of physiological or behavioral responses to stimulus intensities that are close to the putative threshold are carried out. Unfortunately, the signal-to-noise ratio (S/N) naturally is worst near the threshold, since the intensities of evoked responses are positively correlated with stimulus strength. Here we demonstrate that thresholds may be estimated without any near threshold measurements if data are fitted to a generalized logistic function and an additive term representing the measured signal amplitude to the non-stimulus condition is added. We demonstrate that the goodness of fit becomes best if the supporting points are located within the area of the logistic function with the highest gradients, also referred to as its dynamic range, i.e. in a range with good S/N. To become independent from the number of measurement repetitions and the absolute noise level we perform stepwise subsampling with increasing sample-size followed by extrapolation and estimation of the asymptote.

BP 22.3 Mon 17:30 Poster C

Analyzing and modeling dynamics of cortical steady state responses to long lasting stimuli — •Patrick Krauss[1,2], Achim Schilling[1], Konstantin Tziridis[1], Claus Metzner[2], and Holger Schulze[1] — [1]Experimental Otolaryngology, ENT-Hospital, University of Erlangen — [2]Department of Physics, Biophysics Group, University of Erlangen

We present a novel method for analyzing and modeling high-dimensional data such as multichannel cortical recordings, which is derived from multidimensional scaling (MDS). A fundamental shortcoming of classical MDS is the impossibility of assigning coordinates in target space to new points without re-running the entire scaling procedure. To overcome this problem we construct a mapping matrix M from high-dimensional state space to target space while preserving all mutual Euclidean distances. We use our method to reveal the relation between auditory perception and neuronal activity. The temporal development of the spatial activity pattern across the recording channels corresponds to a trajectory in a high-dimensional state space. Projecting trajectories with the matrix M reveals attractor-like dynamics. Remarkably, this finding remains undiscovered when performing other dimensionality reduction methods such as PCA or ICA. In addition, we use an animal model to induce tinnitus. Our method enables inferring the pitch of the tinnitus precept from recorded neuronal data, which we validate using a behavioral tinnitus assessment paradigm. Finally, inverting the matrix M results in a simple generator model of stimulus specific attractor dynamics.

BP 22.4 Mon 17:30 Poster C

Tailored Multielectrode Array as an Interface for Neuronal Networks — •Norman Shepheard[1,2], Matthias Schürmann[3], Ulrich Rückert[2], Barabara Kaltschmidt[3,4], Christian Kaltschmidt[3], and Andy Thomas[1,5] — [1]Center for Spinelectronic Materials and Devices, Physics Department, Bielefeld University, Germany — [2]Cognitronics and Sensor Systems, Bielefeld University, Germany — [3]Cell Biology, Bielefeld University, Germany — [4]Molecular Neurobiology, Bielefeld University, Germany — [5]Leibniz Institute for Solid State and Materials Research Dresden (IFW Dresden), Institute for Metallic Materials, Dresden, Germany

To study neuronal network functions one need the appropriate interface to read out the action potential and to stimulate the neurons. We demonstrate a process to grow guided neuron networks in vitro, as well as to build multielectrode arrays (MEAs), which provides an electrode arrangement fitting to the desired network layout. Soma localization to one electrode is a key point for measurements in networks.

The fabrication of MEAs was done with UV-laser lithography and sputtered thin layers of titanium, titanium nitride for electrodes and silicon nitride as an insulator. The long time stable adhesion layer system is made of (3-aminopropyl)triethoxysilane, glutaraldehyde and poly lysine on top. The patterning of the adhesion layer system for guided neuronal networks is made via UV-laser lithography as well.

This flexible approach allows cell body localization of the neurons and neurite guidance as shown in the results. The network designs fits to the self-built MEAs.

BP 22.5 Mon 17:30 Poster C

Mechanotransduction in the pentamere organ of the Drosophila larva — •Achintya Prahlad[1], Martin Göpfert[2], and Christoph Schmidt[1] — [1]DPI Göttingen — [2]Schwann-Schleiden Research Centre, Göttingen

The fruit fly Drosophila melanogaster uses mechanosensation for several purposes. One class of specialized organs are the chordotonal organs, such as the antennal auditory organ of the adult, and the larval pentamere organ (lch5). The sensory neurons at the core of these organs have one dendrite, which terminates in a cilium believed to be the main mechanotransducer. The lch5 organ aids in locomotion by giving feedback to the CNS. We focus on this organ because its sensory neurons are well accessible to manipulation under the microscope.

Several molecular and anatomical aspects of these organs have been studied. However, an understanding of the internal transduction mechanics is still elusive. The cilia are not directly accessible, so a first step is to study the mechanics of the entire organ. Our specific question is how it deforms in response to muscle contractions - which is important since the basis of locomotion of the Drosophila larva is a complex peristaltic wave of muscle contractions.

We are using a preparation of the larva under buffer solution that allows us to directly contact the lch5. Our approach is to provide controlled push/pull stimuli to the organ using a tungsten needle, and to measure the mechanical relaxation. We are also using laser ablation to cut the tense ligament that the organ is attached to and observe the ensuing deformation of the sensory dendrites.

BP 22.6 Mon 17:30 Poster C

The effect of noise on the transition to chaos in random neural networks — •Sven Goedeke[1,4], Jannis Schuecker[1,4], Markus Diesmann[1,2,3], and Moritz Helias[1,3] — [1]Inst of Neurosci and Medicine (INM-6) and Inst for Advanced Simulation (IAS-6) and JARA BRAIN Institute I, Jülich Research Centre — [2]Department of Psychiatry, Psychotherapy and Psychosomatics, Medical Faculty, RWTH Aachen University — [3]Department of Physics, Faculty 1, RWTH Aachen University — [4]These authors contributed equally

Networks of randomly coupled rate neurons display a transition to chaos at a critical coupling strength (Sompolinsky et al. 1988, PRL). The dynamics close to the transition – at the edge of chaos – provides a powerful substrate for computations. Here, we investigate the effect of additive white noise, representing intrinsic stochasticity or external inputs, on the transition. We develop the dynamical mean-field theory yielding the autocorrelation function. Solving the eigenvalue problem for the maximum Lyapunov exponent allows us to analytically determine the transition from non-chaotic to chaotic activity. Increasing the noise amplitude shifts the transition to larger coupling strengths, i.e., chaos is suppressed. The decay time of the autocorrelation function does not diverge at the transition, but peaks slightly above the critical coupling strength. Partly supported by Helmholtz association: VH-NG-1028 and SMHB; EU Grant 604102 (HBP).